

Air-water carbon dioxide fluxes in a Mediterranean wetland

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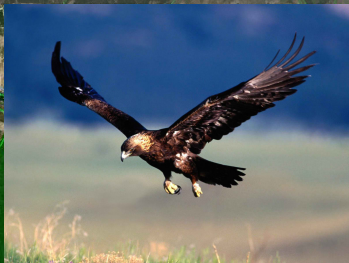


Overview of talk

- Introducing Doñana
- Aquatic carbon transport
- Doñana air-water carbon fluxes
- Conclusions

Doñana Natural Area

Biosphere Reserve, RAMSAR and World Heritage site



Doñana National Park

538 km²

Gulf of Cádiz

Trebu

Las Cabezas de S



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Sanlúcar de Barrameda

Guadalquivir 2nd largest
river in Spain

Doñana Natural Area

Biosphere Reserve, RAMSAR and World Heritage site **UNDER PRESSURE!**



What is the **VALUE** of a wetland?

Doñana Natural Area

Ecosystem services

- Supporting
- Cultural
- Provisioning
- Regulating

CARBON SEQUESTRATION

role in climate regulation?

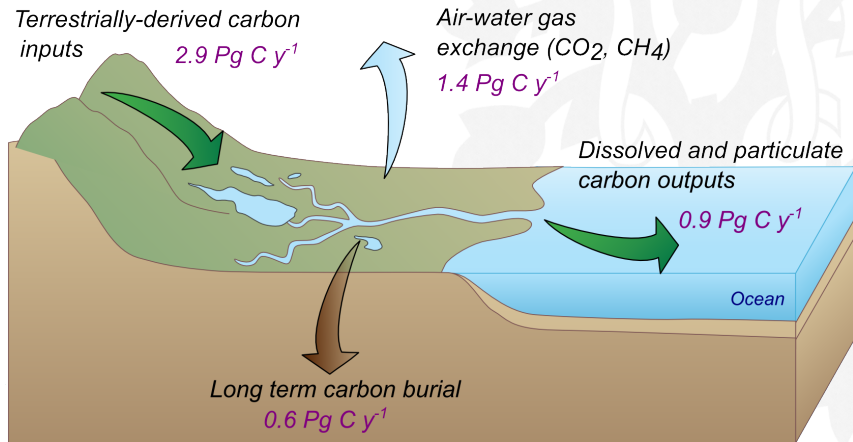
Palomo et al. 2011. Ecology and Society 16(1): 23. URL:

<http://www.ecologyandsociety.org/vol16/iss1/art23/>



Aquatic carbon transport

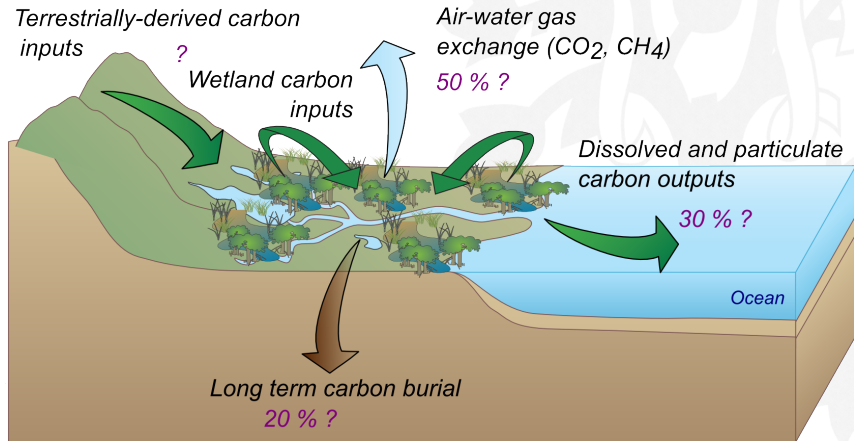
"Active" pipe model (Downing et al. 2008, Battin et al. 2009, Cole et al. 2007, Tranvik et al. 2009, Butman and Raymond 2011)



Aquatic carbon transport

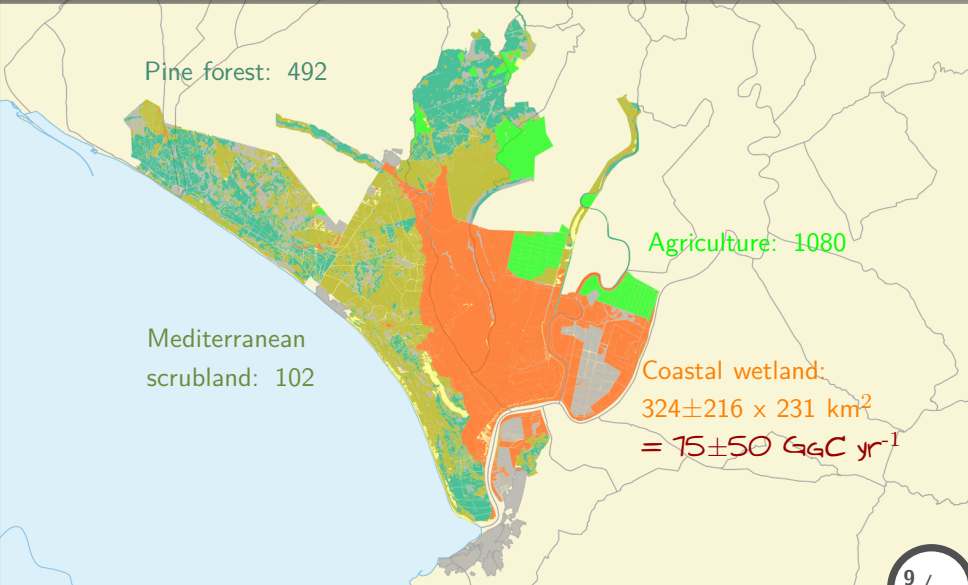
What is the role of wetlands?

Global Wetland area between 6 and 11 %
of continents (Downing 2009)



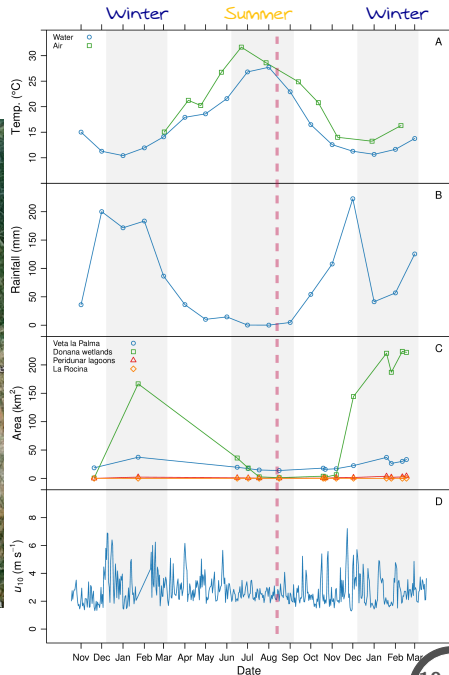
Doñana Natural Area

Potential areal net primary production (NPP, $\text{gC m}^{-2} \text{yr}^{-1}$)



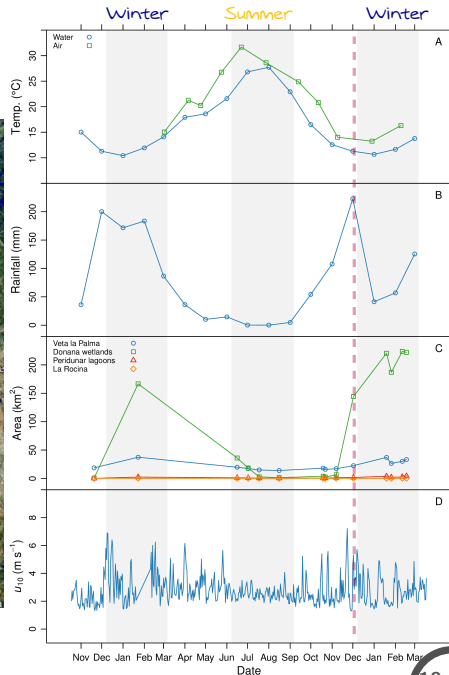
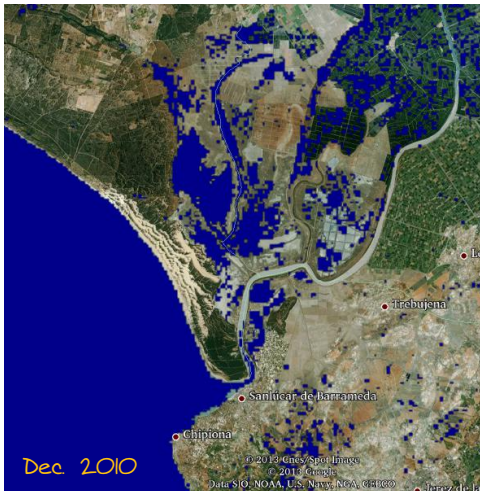
Doñana Natural Area

Seasonal flooding 2010–2011



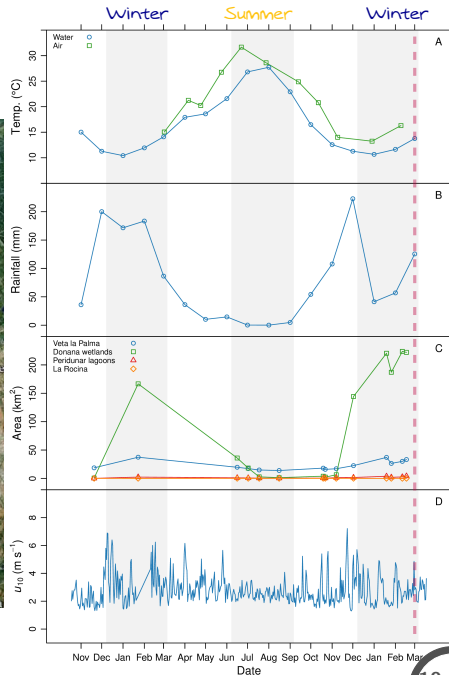
Doñana Natural Area

Seasonal flooding 2010–2011



Doñana Natural Area

Seasonal flooding 2010–2011

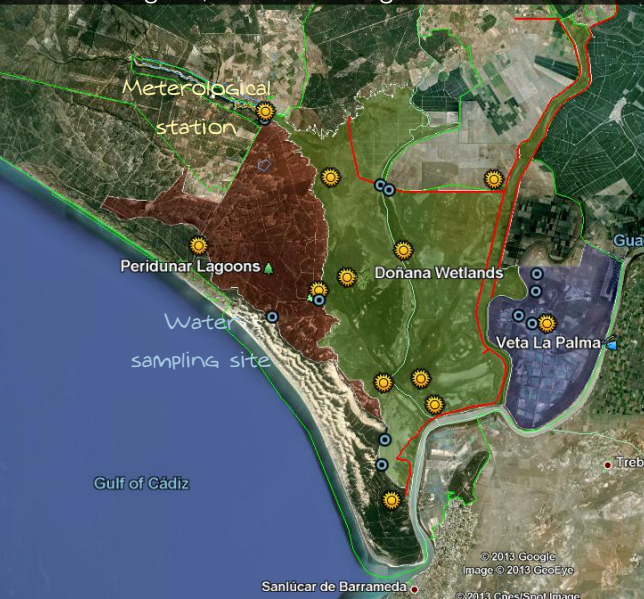


Research question

How **LARGE** is annual
air–water CO₂ transport in
Doñana?

Doñana Natural Area

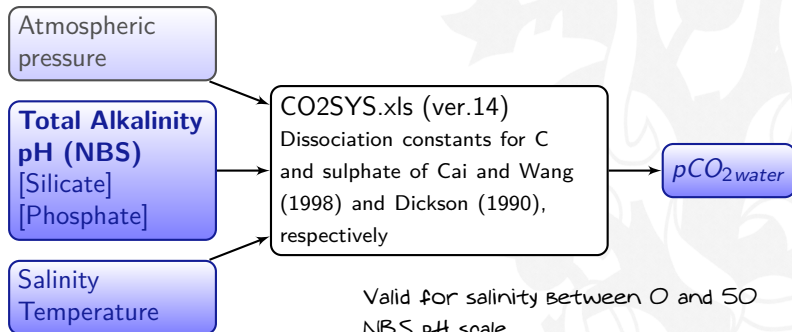
Wetland regions, ICTS meteorological stations and water sampling points



Water samples collected monthly when water level > 0.1 m ($n = 6$ to 12).

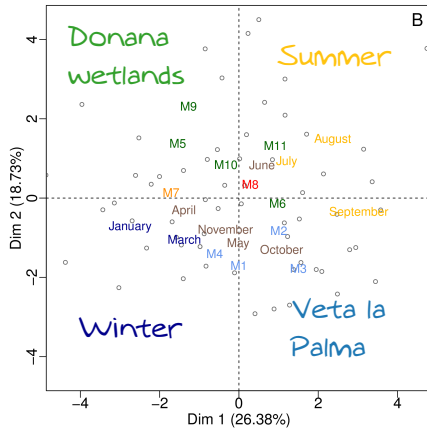
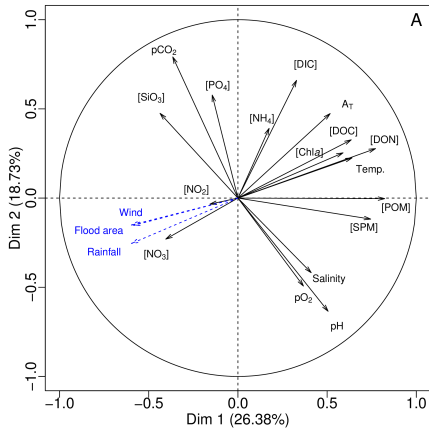
- Temperature
- Salinity
- pH (NBS scale)
- Total Alkalinity
- Oxygen concentration
- Dissolved nutrients
- Total suspended matter (TSM)
- Particulate organic matter (POM)
- Chlorophyll *a*
- Dissolved organic matter (DOM)

Calculating dissolved carbon dioxide

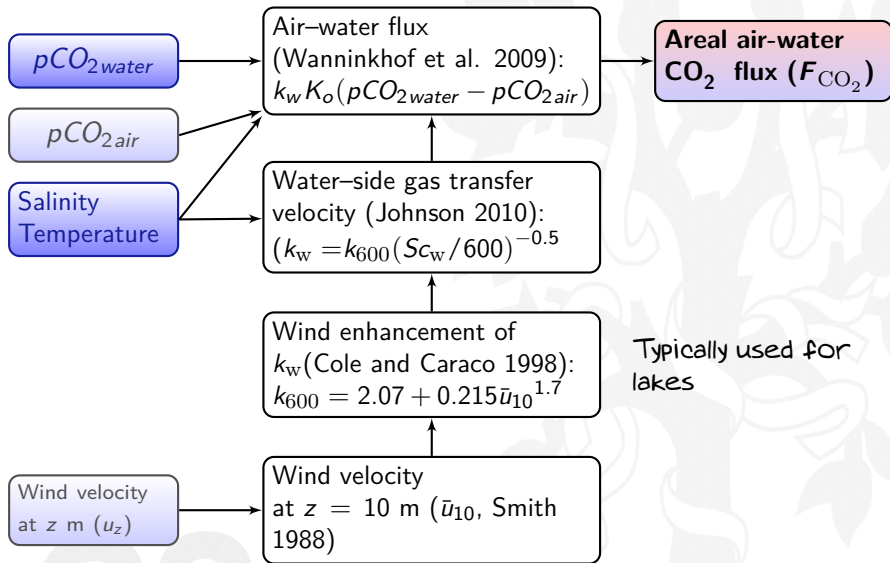


Doñana Natural Area

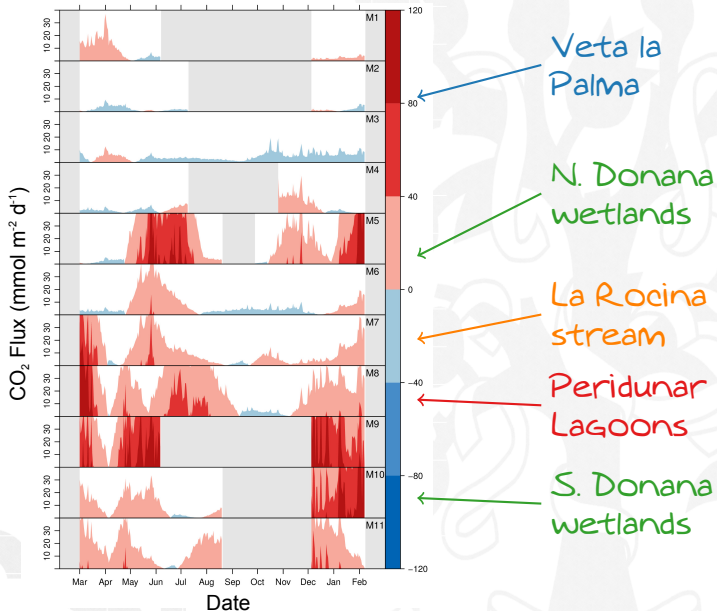
Spatio-temporal variation in aquatic physiochemical properties



Calculating air-water CO₂ fluxes



Doñana air-water CO₂ fluxes (2010–2011)



Doñana air-water CO₂ fluxes (2010–2011)

Table : Summary of annual areal air–water CO₂ fluxes (F_{CO_2}) at each of the sites, range of water coverage and annual air–water C transport in each region.

Region	Site	F_{CO_2} (molCO ₂ m ⁻² yr ⁻¹)	Water extent (km ²)	C transport (GgC yr ⁻¹)
Veta la Palma	M1	1.1	14–37	-0.05
	M2	-0.3		
	M3	-1.4		
	M4	0.5		
Doñana Wetlands	M5	11.9	1–224	12.95
	M6	1.4		
	M9	13.4		
	M10	8.8		
	M11	5.1		
Peridunar lagoons	M8	11.1	0.1–4	0.21
La Rocina	M7	6.0	0–0.1	0.004

RANGE = -1.4 to 13.4 molC m⁻² yr⁻¹

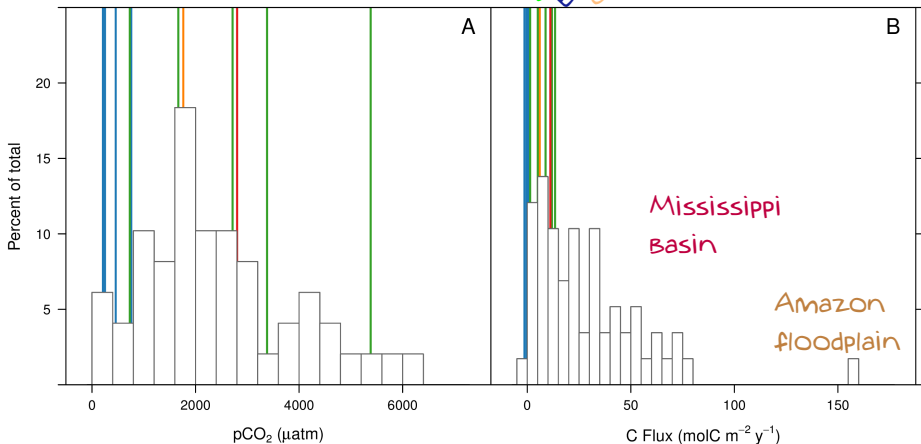
TOTAL = 13 GgC yr⁻¹

Doñana air-water CO₂ fluxes

Comparison with other aquatic systems

Veta la Palma Donana wetlands

Large Lakes
Eur. Estuaries
Guadalquivir



Conclusions

Carbon transport within Doñana Natural Area

- **Annual air-water CO₂ transport in 2010–2011 (13 Gg_C yr⁻¹) was 2 to 10 times less than potential wetland NPP (75 ± 50 Gg_C yr⁻¹).**
 - A first estimate, BUT plenty more work to be done:
 - More years with different hydrology, improved NPP estimate, fluxes during dry period, link with eddy-covariance measurements...
 - How large is export and burial?
 - Methane?

Conclusions

Carbon transport within Doñana Natural Area

- Clear differences in air–water fluxes between wetland type/management regime.
 - Floodwaters are a strong source, whereas aquaculture ponds weak sink of atm. CO_2 .
 - Autochthonous production important when hydroperiod extends through summer–autumn.
- Suggests hydrological management of Doñana will affect C transport

Acknowledgements

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- Landsat data available from the U.S. Geological Survey. DEIMOS1 data provided by DEIMOS-Imaging. Land use Doñana Natural Area available from "Mapa de usos y coberturas vegetales del suelo de Andalusia 2007, escala 1:25.000, REDIAM Consejeria de Medio Ambiente, Junta de Andalusia"
- Data analysis was carried out using R 2.15 (<http://cran.r-project.org>) and QGIS (www.qgis.org). This presentation was created using L^AT_EX and the beamer style of Flip Tanedo.

THANK-YOU

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